

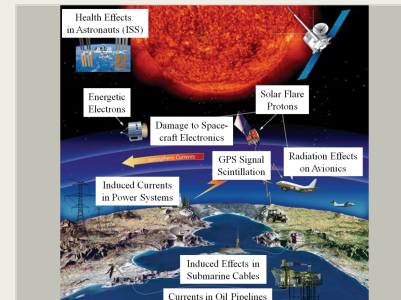
Improved Forecasting of Solar Particle Events and their Effects on Space Electronics, Phase II

Completed Technology Project (2016 - 2019)



Project Introduction

High-energy space radiation from Galactic Cosmic Rays and Solar Particle Events (SPEs) pose significant risks to equipment and astronaut health in NASA missions. Energetic particles from SPEs associated with flares and coronal mass ejections (CMEs) may adversely affect not only beyond-Low-Earth-Orbit missions, but also aircraft avionics, communications, and airline crew/passenger health. It is crucial to develop a capability to forecast SPEs and their effects on systems to guide planning of mission-related tasks and risk mitigation strategies. CFD Research Corporation (CFDRC), University of Alabama in Huntsville (UAH), and Vanderbilt University (VU) propose to develop a comprehensive forecasting capability - SPE Forecast (SPE4) - comprising state-of-the-art modules integrated within a novel computational framework. SPE4 will include: (a) the MAG4 code for probability forecasts of flares/CMEs, and SPEs, (b) the PATH code for solar particle transport through the heliosphere, (c) Geant4-based transport calculations including geomagnetic modulation and atmospheric interactions (for avionics) to yield spectra of SPE-induced energetic protons/heavy ions, interfaced to (d) the CR?ME96 code for calculation of resulting effects in electronics. In Phase I, we demonstrated the superior capability of MAG4, PATH, and Geant4 for their respective tasks using a prior solar event case. A controller script was developed for automated code execution and data transfer across interfaces. Functionality of the overall event-to-effects capability was demonstrated using the 28-Sep-2012 event. We developed a concept of the final software product for NASA based on client-server architecture. In Phase II, we will collaborate with VU to interface calculated particle spectra with CR?ME96 to determine single-event effects in electronics. We will enhance robustness, accuracy, and execution speed via improved models and procedures, and demonstrate the software for persistent 24x7 SPE monitoring.



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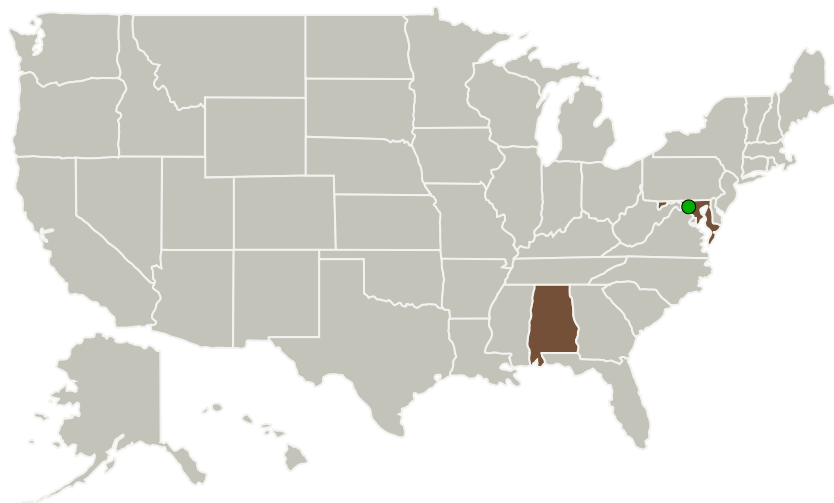
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
● Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland
University of Alabama in Huntsville(UAH)	Supporting Organization	Academia	Huntsville, Alabama

Primary U.S. Work Locations

Alabama	Maryland
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Project Transitions

**September 2016:** Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

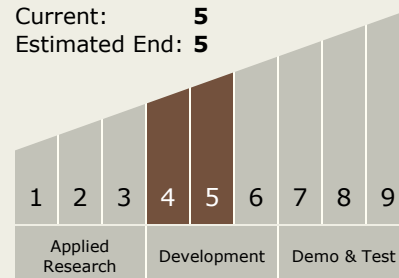
Carlos Torrez

Principal Investigator:

Ashok Raman

Technology Maturity (TRL)

Start: **4**
 Current: **5**
 Estimated End: **5**



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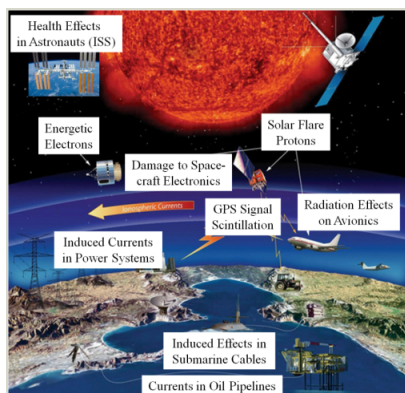


March 2019: Closed out

Closeout Documentation:

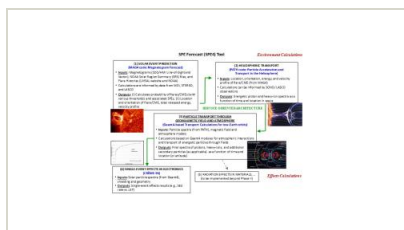
- Final Summary Chart(<https://techport.nasa.gov/file/140789>)

Images



Briefing Chart Image

Improved Forecasting of Solar Particle Events and their Effects on Space Electronics, Phase II
(<https://techport.nasa.gov/image/136853>)



Final Summary Chart Image

Improved Forecasting of Solar Particle Events and their Effects on Space Electronics, Phase II
(<https://techport.nasa.gov/image/128411>)

Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
 - └ TX06.5 Radiation
 - └ TX06.5.4 Space Weather Prediction

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System